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The Quantification of History and the Idealized Paradigm

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Abstract

"Idealization" is the thinking foundation of the paradigm of natural science research since Galileo. For a long time, the difference in the thinking way has been mistakenly regarded as the characteristic of the research field. That has caused the dilemma of theory and practice in the scientization of history. On the basis of strictly following the paradigm of idealized thinking, natural science owns the distinctive features: no subjective value judgment, mathematical modeling that does not rely on statistics, repeatable experiments under laboratory conditions which are suitable for different space-time environments, and the computer programs for simulation. Apparently, those features also are shown in the history. The development and maturity of artificial intelligence technology requires not only the improvement of computer technology and human brain science, but also the completion of non-statistical modeling and computer programming of human historical behavior patterns.

Keywords: Idealized Thinking; Historical Research; Trilateral Coexistence Model

Traditional historical research relies on the study of textual sources on historical events to produce a qualitative analysis. In the middle of the 20th century, the rise of cliometrics attempted to enrich History's tool case by introducing quantitative calculation, which depended heavily on statistics. In classic works of cliometrics [1], all research cases must use statistics to draw conclusions. Just as the British historian Geoffrey Barraclough observed, [Cliometrics] is limited, quite deliberately, to the economic substructure; the only quantitative history is therefore quantitative economic history... it is applicable only in the period (not much further back than 1780) in which adequate statistical data are available; and this means... that it can only be used for the history of those parts of the world namely, Europe and North America- where concern with the statistics of national accounting developed at a (relatively) early date [2].'

After the 1980s, researchers began to re-examine the relationship between cliometrics and the scientization of history. Emmanuel Le Roy Ladurie, an ardent proponent of French cliometrics, observed that the pioneers of cliometrics in the period between 1950 and 1970 had overestimated the role of metrology research and Information Technology (IT) in the scientization of History [3]. Robert Fogel, a representative of American cliometrics also stated that "quantification will not transform history into a natural science but merely expand the store of scientifically validated knowledge on which historians can draw" [4]. Georg Iggers, who has long been concerned over changes in historical paradigm, noted that "the past few years have seen a profound disillusionment with the quantitative approaches which were at the core of would-be scientific history" [5].

The reason for the dilemma of scientization of history lies in the fundamental difference in thinking paradigm between cliometrics and modern natural science research since Galileo. Historical quantitative research under the idealized paradigm can make up for the lack of cliometrics. This paper uses our Trilateral Coexistence Model as an example to demonstrate it.

One of Galileo's most important contributions to scientific methodology was his knack of "idealizing" a problem. "He was able to reduce each problem to its basic, essential form; to eliminate factors not immediately relevant; to reach 'laws' that did not describe the motion of any actual body, but rather stated what its behavior would be if the influence of environment were eliminated or standardized. For example, idealization treats the earth's surface as a plane, and perpendicular to it as parallel. It ignores friction and resistance in the study of falling bodies. It conceives the idea of the mass-point. Galileo was able to distinguish between the primary and secondary qualities of Aristotle and concentrate on measuring the former. He by-passed the complex problem of causes in order to discover a mathematical description. This knack of idealizing enabled Galileo to go right to the heart of a problem and develop a simple mathematical theory [6]."

In view of this, we provide readers with the following historical scientific ideas that strictly follow the natural science thinking paradigm.

1. Identify the research issue and clarify the specific meaning of the issue;
2. Establish an ideal state and clarify the ideal concept needed

to solve the issue;
3. Design an ideal experiment, and carry out mathematical modeling in the field of history according to the specific meaning in step 1;
4. Design realistic experiments, create suitable conditions for mathematical models by controlling variables in the laboratory, and obtain experimental conclusions to test and adjust the model.
5. Write a computer program, and the computer program that reflects the inherent logical relationship of the historical process according to the mathematical model in step 3 that has been checked in step 4.
The author now uses the "Trilateral Coexistence Model" as a research case to explain in detail:

Identify research issue

The question of "Trilateral Coexistence" is to explore the conditions under which three neighboring countries can coexist. The coexistence here means that no country will be annexed by other two countries.

Establish an ideal state

The Trilateral Coexistence Model explores the mathematical expression and correlations of a system where three neighboring countries coexist in ideal conditions (which assumes that decision-makers in all three political entities are driven by reason and pursue their country's interest, similar to Adam Smith's economic man hypothesis). The mathematical expression of the Trilateral Coexistence Model is as follows.

Under ideal conditions, if the r*elative operational combat effectiveness* of the three countries (α, β, and γ) meet the conditions $CE_{\alpha \text{ relative}\beta} > 0$ $CE_{\alpha \text{ relative}\gamma} > 0$ $CE_{\alpha \text{ relative}(\beta+\gamma)} < 0$, $CE_{\beta \text{ relative}\gamma} \neq 0$, then the three countries can coexist [7].

"CE" in the model means combat effectiveness. The theory of territorial behavior postulates that the essence of territory comprises a mass of physical space belonging to a political authority that ought to be defended and asserts that fighting will occur if armed forces of another political entity cross its boundaries. Combat, in other words, can be defined as a confrontation between armies on occasion either of an invasion of territory or to defend against an invasion. By implication, combat effectiveness is the ability to invade or ward off an attack, essentially the ability to alter or maintain territorial boundaries. Changes in territorial boundaries can be used to measure combat effectiveness. This leads to the following formula or measurement of combat effectiveness:

$$CE = \frac{\Delta S_{army}}{t} \quad (1)$$

In the formula, CE is the total combat effectiveness of an army; ΔSarmy represents changes in a state's total area caused by the combatting army; and t is the time required to alter the total area [8].

Design Ideal Experiments and Conduct Mathematical Modeling

In the ideal state, it is assumed that there are three ideal countries α, β, and γ, and the land expansion speed is satisfied

$$CE_\alpha > CE_\beta,\ \mathrm{CE}_\alpha > \mathrm{CE}_\gamma \text{ and } \mathrm{CE}_\alpha < \mathrm{CE}_\beta + CE_\gamma.$$

Situation 1:

$$\because \mathrm{CE}_\alpha < \mathrm{CE}_\beta + CE_\gamma,$$

$$\therefore CE_\alpha - CE_\beta < CE_\gamma.$$

That is to say, if there is a war between the country α and β, the difference between the expansion speeds of those two countries will be smaller than that of the country γ. The country γ can wait for the country α and β to be destroyed after they are defeated.
Situation 2:

$$\because CE_\alpha < \mathrm{CE}_\beta + CE_\gamma,$$

$$\therefore \mathrm{CE}_\alpha - CE_\gamma < \mathrm{CE}_\beta.$$

That is to say, if there is a war between the country α and γ, the difference between the expansion speeds of those two countries will be smaller than that of the country β. The country β can wait for the country α and γ to be destroyed after they are defeated.
Situation 3:

$$\because \mathrm{CE}_\alpha > \mathrm{CE}_\beta,$$
$$\therefore \mathrm{CE}_\alpha > \mathrm{CE}_\beta - CE_\gamma,$$

$$\text{Again } \because \mathrm{CE}_\alpha > \mathrm{CE}_\gamma,$$

$$\therefore \mathrm{CE}_\alpha > \mathrm{CE}_\gamma - CE_\beta$$

$$\therefore \mathrm{CE}_\alpha > |CE_\beta - CE_\gamma|.$$

That is to say, if there is a war between the country β and γ, the difference between the expansion speeds of those two countries will be smaller than that of the country α. The country α can wait for the country β and γ to be destroyed after they are defeated.
It can be seen that in the ideal state, if any two of the three countries have a war, the difference between the expanding speeds of the two warring countries will be lower than that of the third country, and eventually all the land will be occupied by the third country, and the country that started the war will become a loser. Therefore, the three countries will not take the lead in launching a war, and the result will be peaceful coexistence with each other.

Artificially Simulate the Ideal State in the Laboratory, And Conduct Repeatability Experiments

In order to verify the Trilateral Coexistence Model obtained through the ideal experiment, we used the card area to simulate the ideal country's footprint, and designed a laboratory repeatability experiment. The experimental records are as follows:
Experiment time: July 18, 2022 17:05-23:42.
Experimental location: Shaanxi Branch of Ideal History Re-

search (Weinan City, Shaanxi Province, China). Experimental conditions: Fully understand the three players in ideal state A, four sets of brand new unopened "AAA playing cards", and a horizontal round table with a diameter of 76cm.

Experimental staff: Ph.D.Sun, Ph.D.Liu, Ph.D.Wang.

Experimental design: Three people sat around a round table, each with 60 playing cards and a stopwatch. The rule of the game is that everyone is randomly assigned a rated speed for moving cards, and the direction of the cards is arbitrary (you can put others' cards in your own pile, or you can put your own cards in others' piles, you can also put other people's cards into the third-person's pile), the player with zero card number will be eliminated, and if there is one person left, that person will win. Throughout the game, the trio's card-winning speed and remaining cards are well known. The three must always take their victory as the only will in their minds, and the environment is not destructive to the cards.

Experimental Process and Results

In the first phase of the experiment (17:05-21:58), we tried the situation in which the three-person card winning speeds were "30 cards/minute, 20 cards/minute, and 15 cards/minute". For the first time, Ph.D.Sun took the initiative to win the cards, and evenly won from Ph.D.Liu and Ph.D.Wang. Because Ph.D.Sun won the card the fastest, Ph.D.Liu and Ph.D.Wang united to win the card against Ph.D.Sun. When 10 minutes passed and Ph.D.Sun had only 10 cards left, Ph.D.Liu had 110 cards, and Ph.D.Wang had 60 cards, in order to prevent Ph.D.Liu from having an advantage over Ph.D.Wang after Ph.D.Sun was out, Ph.D.Wang began to help Ph.D.Sun seize Ph.D.Liu of playing cards. It was not until 2 minutes later that Ph.D.Sun had 70 cards, Ph.D.Liu had 20 cards, and Ph.D.Wang had 90 cards. Ph.D.Sun and Ph.D.Liu appeared in a union of about 30 seconds. Ph.D.Liu began to repeat the previous cycle with Ph.D.Wang. Then we experimented with the situation where Ph.D.Liu and Ph.D.Wang took the initiative to win the card and the case where Ph.D.Sun won the card from one of Ph.D.Liu and Ph.D.Wang, and found that after a short period of time, the situation would enter into Ph.D.Liu joint Ph.D.Wang again, for the beginning of the cycle.

In the second phase of the experiment (22:20-23:42), we tried the three players' card winning speeds of "30 cards/minute, 20 cards/minute, 5 cards/minute", "30 cards/minute, 10 cards/minute, 10 cards/minute", "30 cards/minute, 12 cards/minute, 6 cards/minute". Each time, Ph.D.Sun took the initiative to evenly win Ph.D.Liu and Ph.D.Wang, and won after 24 minutes, 12 minutes and 10 minutes respectively.

Result analysis: In the first stage of the experiment, because Ph.D.Sun won the card the fastest, Ph.D.Liu and Ph.D.Wang were the easiest to unite. Until Ph.D.Sun had about 10 remaining cards, Ph.D.Wang would definitely be out after Ph.D.Sun was out, so he turned to join Ph.D.Sun. Because Ph.D.Wang got a lot of cards in the union, Ph.D.Sun and Ph.D.Liu will have a short-term union, but as long as Ph.D.Wang's cards were reduced to below 40, Ph.D.Liu would choose to join Ph.D.Wang again. Since every attempt to win a card can't break the coexistence relationship, in the end it can only confront each other and no one wants to take the initiative to win the card again. In the second phase of the experiment, since the winning speed of Ph.D.Sun > that of Ph.D.Liu and Ph.D.Wang, no matter what choices Ph.D.Liu and Ph.D.Wang make, they would inevitably get out of the game.

In the ideal state A, the ideal country has a single national will (only wants to expand the territory) and all the national wills are the same, so individuals who win with themselves as the only will in their minds at all times can be regarded as their actual performance. In addition, the experiment also requires that the environment is not destructive to the cards (for example, the card surface cannot be damaged due to rain). Because the area of each card is equal to each other's, it can be used as a realistic expression of the ideal land in an ideal state. Under the premise of satisfying the above conditions, the real experiment is repeatable, and interested readers are welcome to test it. Of course, because the historical research of idealized thinking is still in its infancy, the above-mentioned real experiments are unavoidably rough compared with the professional laboratories created by modern physics precision instruments.

Carrying Out Simulation Experiments on the Computer

In addition to the repeatable experiments in the above-mentioned laboratory sense, the historical mathematical models obtained through ideal experiments can also be used for computer simulation experiments using the Net Logo platform. As shown in Figure 1, CE_{α}=10, CE_{β}=5, CE_{γ}=6, it is the result of running 3500 times in an ideal state.

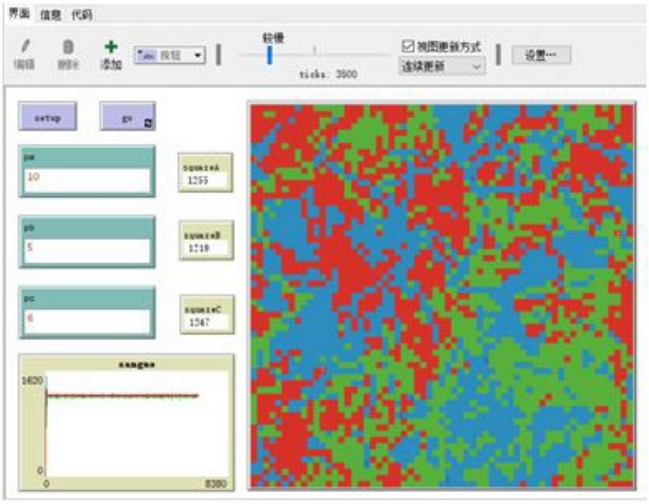

Figure 1: Computer Simulation Experiment Results of the Trilateral Coexistence Model

The program written in this experiment based on Lisp language is:

```
Globals [square A square B square C ]
breed [A aA]
breed [B aB]
breed [C aC]

to setup
  clear-all
    set-default-shape A "person"
    set-default-shape B "person"
```

```
  set-default-shape C "person"
  create-A pa [
    set color blue
    setxy random-xcor random-ycor
  ]
  create-B pb [
    set color lime
    setxy random-xcor random-ycor
  ]
  create-C pc [
    set color orange
    setxy random-xcor random-ycor
  ]
  reset-ticks
end

to go
  ask turtles [
  set squareA count patches with [pcolor = sky]
  set squareB count patches with [pcolor = green]
  set squareC count patches with [pcolor = red]
    ifelse squareA >= squareB and squareA >= squareC
  [
  ask A[
    fd 1
    while [ pcolor = sky ] [ fd 1 lt random 360 ]
    while [ pcolor = black or pcolor = red or pcolor = green ] [set
pcolor sky ]
  ]
  ask B[
    fd 1
    while [pcolor = green or pcolor = red ] [ fd 1 lt random 360 ]
    while [pcolor = black or pcolor = sky ] [set pcolor green ]
  ]
  ask C[
    fd 1
    while [pcolor = red or pcolor = green ] [ fd 1 lt random 360 ]
    while [pcolor = black or pcolor = sky ] [ set pcolor red ]
  ]
  ]
  [
     ifelse squareB > squareA and squareB > squareC
  [
  ask A[
    fd 1
    while [pcolor = sky or pcolor = red ] [ fd 1 lt random 360 ]
    while [pcolor = black or pcolor = green ] [set pcolor sky ]
  ]
  ask B[
    fd 1
    while [pcolor = green ] [ fd 1 lt random 360 ]
     while [pcolor = black or pcolor = sky or pcolor = red ] [set
pcolor green ]
  ]
  ask C[
    fd 1
    while [pcolor = red or pcolor = sky ] [ fd 1 lt random 360 ]
    while [pcolor = black or pcolor = green ] [set pcolor red ]
  ]
  ]
  [
  ask A[
    fd 1
    while [pcolor = sky or pcolor = green ] [ fd 1 lt random 360 ]
    while [pcolor = black or pcolor = red ] [set pcolor sky ]
  ]
  ask B[
    fd 1
    while [pcolor = green or pcolor = sky ] [ fd 1 lt random 360 ]
    while [pcolor = black or pcolor = red ] [set pcolor green ]
  ]
  ask C[
    fd 1
    while [ pcolor = red ] [ fd 1 lt random 360 ]
    while [pcolor = black or pcolor = sky or pcolor = green ] [set
pcolor red ]
  ]
  ]
  ]
  ]
  do-plot
  tick
end

to do-plot
  set-current-plot "sanguo"
  set-current-plot-pen "A"
    plot(( squareA ))
  set-current-plot-pen "B"
    plot(( squareB ))
  set-current-plot-pen "C"
    plot (( squareC ))
end

to setup-plot
end
```

Using the above code, we selected the most representative 8 kinds of simulation experiments in the input box, and the results are as follows:

Table 1: Statistical Table of Computer Simulation Experiment Operation of The Trilateral Coexistence Model

input value			consequent	Representative situation
10	10	10	The speed of land expansion is cyclically increasing and decreasing, and the three countries coexist.	The expansion speed of the three countries is equal to each other
10	9	8	The speed of land expansion is cyclically increasing and decreasing, and the three countries coexist.	The expansion speed of the three countries is relatively similar
10	10	7	The speed of land expansion is cyclically increasing and decreasing, and the three countries coexist.	The expansion speed of the two strongest countries among the three countries has the same speed
10	6	6	The speed of land expansion is cyclically increasing and decreasing, and the three countries coexist.	The expansion speed of the two weak countries in the three countries is equal
200	2	199	The speed of land expansion is cyclically increasing and decreasing, and the three countries coexist.	The difference in the expansion speed of the three countries is very different
5	1	3	The difference in the speed of land expansion appears, and the reunification speed of the three countries is relatively similar	The expansion speed of the three countries is relatively similar
200	1	1	The difference in the speed of land expansion appears, and the reunification speed of the three countries is relatively similar	The difference in the expansion speed of the three countries is very different

The computer simulation experiment and laboratory "card game" experiment are consistent in the process and the results. The difference between the two is reflected in the fact that due to the delayed effect of the human brain, the situation of "two weak joints against one strong" in laboratory experiments cannot be changed in real time as the strength of the three parties increases and decreases as in computer simulation experiments. Because this is an inherent interference factor of the human brain, the computer simulation experiment is closer to the ideal state.

Conclusion

We present a quantitative method of history based on the idealized paradigm and explain how this method can be applied to data measurement and mathematical modeling. Future research should extend the measurement of combat effectiveness and Trilateral Coexistence to the economic and ideological fields. In addition, we plan to apply the method proposed in this paper to measure the combat effectiveness of armies across human history and perhaps build a database that can serve as a pool of resources for military mathematical models and military simulation software.

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7. See Weipu Sun, the scientific laws, mathematical models, and computer codes behind historical phenomena (Beijing: Kyushu press,2019) for the detailed proof process of the model.
8. For more explanation on this measurement method, see Weipu Sun, Historical philosophy and mathematics (Tianjin:Tianjin People's publishing house, 2017).